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RedCap / NR-Light Enhancements in Rel-18

RAN Rel-18 Workshop

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Nokia, Nokia Shanghai Bell

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RedCap enhancements: Motivations

1. Cost / complexity reduction

Rel-17 has only one type of RedCap device, supporting high peak data rates (e.g. ~85 Mbps DL/UL for FR1 FDD device with 1Tx-1Rx).

Several IoT use cases do not need such high data rates.

Target substantial further reduction in device cost by reducing supported data rate, e.g. comparable to LTE Cat-1bis UE

2. Power consumption reduction

Crucial for IoT applications.

Power consumption can be reduced with narrowband monitoring in the downlink especially for IoT use cases with mostly uplink transmissions

3. Positioning with low complexity and low power

Important in many IoT applications, such as asset tracking.

Low-complexity, low-power positioning can significantly expand the NR-based IoT eco-system.

4. Coverage enhancement

Enabling coverage in challenging locations, e.g. deep indoors

Target 10dB MCL increase compared to Rel-17 RedCap

Not targeting LPWA / underground meter-reading use case

Expand RedCap ecosystem, targeting **automation & control**, **sensing** and **asset tracking**, within constraints:

- Avoid major redesign of NR lower layers => RF bandwidth not less than 5 MHz
- Maintain reasonable spectral efficiency => MCL increase not more than 10dB

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RedCap enhancements: Objectives

- Cost and complexity reduction
  - Specify a very low complexity RedCap device type for FR1 with peak rates comparable to LTE Cat1bis UE (10 Mbps DL, 5 Mbps UL)
    - Reduced UE bandwidth with minimum not less than 5 MHz, reduced number of HARQ processes, reduced peak data rates, relaxed processing times, etc.
- Improved power consumption
  - Narrowband operation and enhanced power saving techniques, e.g. narrowband monitoring and measurements within a portion of a bandwidth part
  - Power-efficient beam management, e.g. simplified beam management procedures, beam failure detection and recovery optimization for stationary and low-mobility devices
  - Extended DRX for RRC Inactive with eDRX cycles up to 10485.76 s (if not completed in Rel-17)
  - Improved MO/MT SDT for RedCap
- Positioning
  - Low-complexity, low-power positioning support, e.g. reduce required device bandwidth for high accuracy positioning and optimized PRS reception
- Coverage enhancement
  - Up to 10 dB MCL increase compared to Rel-17 RedCap baseline, using e.g. repetitions, frequency hopping, compact DCI, sub-PRB PUSCH transmission.
- Higher data rates
  - ACK/NACK bundling for HD-FDD UE

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Background

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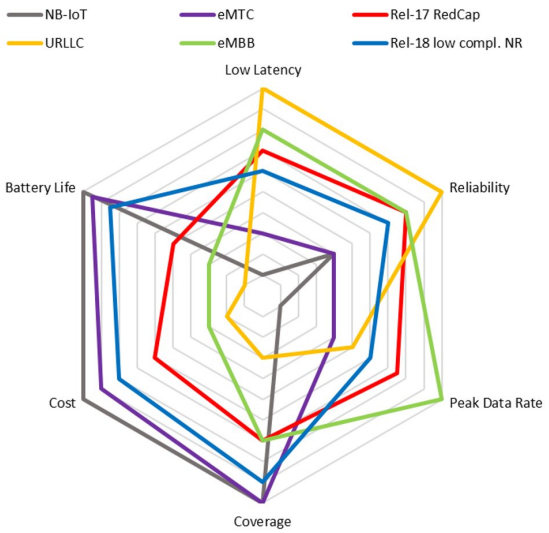
RedCap enhancements: Rel-18 targets

	FR1		
	Reference NR UE	RedCap (Rel-17)	RedCap (Rel-18)
Maximum Bandwidth	100 MHz	20 MHz	5 MHz
Peak data rate	-	~85 Mbps	[10] Mbps DL, [5] Mbps UL
Antenna configuration	1Tx-2Rx	1Tx-1Rx, 1Tx-2Rx	1Tx-1Rx
DL MIMO support	Yes	Yes for 2Rx	No
Duplex mode	FD-FDD / TDD	FD-FDD, HD-FDD / TDD	HD-FDD / TDD
Maximum modulations	256-QAM DL, 64-QAM UL	256-QAM DL (optional) 64-QAM DL (mandatory), 64-QAM UL	64-QAM DL, 16-QAM UL
Other complexity reduction techniques			Reduced number of HARQ processes, TBS limitation, relaxed processing time (e.g. cross-subframe scheduling)



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RedCap enhancements: Complexity reduction analysis

	Reference NR UE	Rel-18 RedCap UE
RF: Power amplifier	25.0%	25.0%
RF: Filters	10.0%	5.0%
RF: Transceiver (including LNAs, mixer, and local oscillator)	45.0%	22.5%
RF: Duplexer / Switch	20.0%	4.0%
RF: Total	**100.0%**	**56.5%**
BB: ADC / DAC	10.0%	0.3%
BB: FFT/IFFT	4.0%	0.1%
BB: Post-FFT data buffering	10.0%	0.3%
BB: Receiver processing block	24.0%	2.2%
BB: LDPC decoding	10.0%	0.2%
BB: HARQ buffer	14.0%	0.1%
BB: DL control processing & decoder	5.0%	2.5%
BB: Synchronization / cell search block	9.0%	0.5%
BB: UL processing block	5.0%	1.4%
BB: MIMO specific processing blocks	9.0%	4.5%
BB: Total	**100.0%**	**10.8%**
RF+BB: Total (with RF:BB cost split 40:60)	**100.0%**	**29.1%**

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